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MINERAL EXPLORATION NORTH OF 60

TRENDS AND ACHIEVEMENTS

BY

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R. W. Hornal and D. B. Craig

ABSTRACT

In 1970, 12 mines with reserves valued at over 3.7 billion dollars operated in Canada's northland and several small operators produced nickel, silver and gold from small high-grade deposits. In addition mineral occurrences were known with a metal content valued at over 25 billion dollars.

Mineral exploration programs in the Yukon were designed to detect large low-grade copper-molybdenum deposits, copper deposits, lead-zinc deposits, tungsten deposits and coal deposits. In the Northwest Territories, the search for copper, lead-zinc, nickel, silver, uranium and tungsten deposits was widespread.

Areas of exploration activity for the next few years will include the greenstones of the Slave and Churchill Provinces, the Mackenzie and Selwyn Mountain belts, the Arctic Islands, the basic and ultrabasic rocks in the northern Keewatin and northeastern Mackenzie districts, the East Arm of Great Slave Lake, the Dawson and Nisling ranges and the Camsell River-Great Bear Lake region.

The Federal Government is actively promoting exploration and development in the North as such development can benefit the northern people and the people of Canada. It recognizes that development in the north requires special safeguards for the environment and, to this end, it has drafted legislation to control pollution.

New methods of mining and transportation will hasten the development of the known mineral deposits of the north. It is not unreasonable to anticipate a substantial increase within the decade in the value of minerals mined north of the sixtieth parallel of latitude.

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INTRODUCTION

As 1970 marked 100 years of Canadian rule over the mainland portions of the Yukon and the Northwest Territories and 90 years of Canadian rule over the Arctic Islands, it is an excellent time to summarize the present status of the mining industry north of the sixtieth parallel of latitude and to consider present trends in mineral exploration in this vast territory, 41% of the Canadian land mass.

Mineral production from this area began with a boom - the Klondike Gold Rush - in the late 1890's. Between 1898 and 1905 more than 111 million dollars worth of gold was mined from the gravels of creeks near Dawson but the boom quickly faded and by 1907 most placers were exhausted. The discovery of silver and pitchblende on the shores of Great Bear Lake in the early 1930's and of gold at Yellowknife in the latter part of the decade brought mining to the north to stay.

The inhospitable climate and lack of transportation facilities restricted the exploitation of minerals other than precious metals until the early 1960's. The completion of the Pine Point railroad in 1964 marked the beginning of a new era in mining in the north and, today, base metals contribute far more to the mineral economy of the north than do precious metals.

By 1970 twelve mines were operating in the north, with reserves worth more than 3.7 billion dollars (Table 1); several small operators were producing from high-grade nickel, silver and gold deposits; and mineral occurrences with a metal content valued at over 25 billion dollars had been discovered. (Table 2). The proven existence of these deposits is encouraging to those of us involved in the search for new deposits in the north.

Details of producing mines and a complete list of exploration programs undertaken in 1970 can be found in the preprint of "Mining North of 60" available from the Department of Indian Affairs and Northern Development who have a display

booth in the exhibit area. The following is an outline of the highlights of the 1970 exploration season and a prediction of areas of interest in the years ahead.

EXPLORATION, 1970

Exploration activity in the Yukon Territory during 1970 was concentrated in the Dawson Range where some 20 helicopters were at work during the summer months. Most expenditures were made by major companies or their joint ventures and subsidiaries, but significant exploration was also achieved by individuals and partnerships. Several of the major companies conducted regional programs, essentially prospecting and geochemical reconnaissance, as well as property examinations.

In the Northwest Territories exploration activity was widespread. Much of the activity has, in the past two years, moved from the Mackenzie District to the Keewatin where 77 permit areas are presently held by mining and oil companies searching for uranium, nickel, iron and copper. Because of the limited transportation facilities in the Keewatin any program in this region is expensive, therefore,the companies have attempted to conduct as thorough an investigation as possible. Programs begin with aerial geophysics which is followed by ground geophysics and by geological mapping and, then, by detailed examinations of the best showings.

A brief summary of exploration programs by the metal sought follows.

Copper-Molybdenum

In the Yukon the single most important stimulus to exploration was the 1969 discovery of a major porphyry copper-molybdenum deposit in the Dawson Range, 190 miles northwest of Whitehorse on the property of Casino Silver Mines Ltd. The property lies at the heads of Canadian and Casino Creeks ($62^{o}43'N$ $138^{o}49'W$).

Canadian Creek has been of interest since the turn of the century as a gold-tungsten placer deposit. Before 1940, silver-lead veins were discovered and these were stripped by bulldozer in 1965. Underground exploration, consisting of 1200 feet of drifting and crosscutting was done in 1966. The geological aspects and exploration sequence which led to the identification of the copper-molybdenum porphyry have been presented (Archer and Main, in press) and are summarized here. The existence of a copper deposit was inferred by the associated mineral occurrences (gold-tungsten placers and silver-lead veins), pronounced leaching, alteration and a transported gossan. The area of the deposit was located by stream sediment and soil grid geochemistry as well as by geological mapping. The discovery was made by diamond drilling which established significant intersections of ore grade material in June of 1969.

The mineralization is associated with the Casino Stock, an early Tertiary body some 2000 feet wide and 5000 feet long composed of quartz porphyry breccia and feldspar porphyry. A leached capping, overlying the mineralized zone, is some 30 feet thick in creek beds and up to 350 feet thick on hilltops. In this zone copper and molybdenum have been depleted 70 per cent and the remaining minerals have been oxidized. A zone of secondary enrichment, 100 to 300 feet thick in which chalcopyrite and pyrite are replaced and coated by chalcocite, underlies the leached capping. The grade of this enriched zone is roughly double that of the protore.

Casino, while completing a detailed exploration of the mineralized zone, drilled a total of 37,000 feet with standard diamond drills and 17,500 feet with 4 7/8 inch rotary drills. Additionally they mapped 45 miles of bulldozer ripper trenches. The deposit, on the basis of rock types, alteration, mineralization, structure and enrichment, is now recognized as closely resembling Arizona porphyry copper deposits and is the first such in the Yukon (Phillips and Godwin, 1970). Casino has announced reserves of

179 million tons having a grade of 0.37% Cu, 0.023% Mo for a copper equivalent of 0.45%, with a stripping ratio of 1.67 to 1.0.

The Phelps Dodge Corp. of Canada Ltd. investigated their Raft Creek molybdenum property (61°31'N, 138°25'W) with a geochemical survey, surface mapping and a small drilling program. Coarse molybdenite crystals and chalcopyrite veinlets or fracture fillings in quartz veins occur in an alaskite of late Mesozoic age.

Several companies were active in the area of the Kluane Ranges, south of the Shakwak Valley. Imperial Oil Enterprises Ltd. completed a geochemical survey of their Cork claim group (61°20'N, 139°30'W) at the head of Burwash Creek. Eight holes with a total footage of 4,000 feet were diamond drilled. The rocks are argillites and Mush Lake volcanics, intruded by a feldspar porphyry and a granodiorite. The porphyry is sparsely mineralized with chalcopyrite and molybdenite.

Jackpot Copper Mines, as a result of ground geophysics in 1967 and bulldozer trenching in 1968 and 1969, drilled 5 holes with a total footage of 1,700 feet to test the width and continuity of a shear zone copper deposit (60°03'N, 137°07'W). Results so far indicate that the zone is mineralized with chalcopyrite for several hundred feet along strike with widths ranging from 2 to 7 feet.

Silver City Mines Ltd. (61°47'N, 140°47.5'W) drove a 1,500 foot exploratory adit into their main showing on the White River. Native copper and chalcocite with minor chalcopyrite are present as stringers and pods in the Mush Lake basalts and andesites of Triassic age.

Lewes River Mines Ltd. (60°44'N, 135°00'W) holds a large block of claims north, east and south of the city of Whitehorse. Recognizing that this overburden covered area must contain the same

contact zone between the Whitehorse Stock and Lewes River sediments that is the host of the New Imperial orebodies on the west side of the Yukon River, the company carried out extensive geophysical surveys in 1968 and 1969. Helicopter-borne magnetic surveys were helpful in delineating the intrusive-sediment contact. Areas along this contact were then subjected to ground magnetometer and I.P. surveys. In 1969, 4 diamond drill holes explored one such selected target area. In 1970 a total of 5,500 feet of BQ diamond drilling in 11 holes on the 1969 target and two others was done.

In the Northwest Territories the search for copper shifted from the Coppermine River area to the greenstone belts of the Slave geological Province, to the Ennadai-Rankin Inlet greenstone belt and to the Penrhyn Group of Aphebian metasediments at the southern end of the Melville Peninsula.

The volcanics and sediments of the Yellowknife Supergroup have long been prospected on foot for gold and base metals but it was not until 1970 that some of these belts were flown by the sophisticated geophysical equipment used so successfully in Ontario and elsewhere to delineate significant anomalous areas before staking. Freeport Oil Company (Alberta) Ltd. conducted the first of these surveys over the Indin Lake greenstone belt in April of 1970. Similar surveys were flown by Shield Resources Ltd. and the Keevil Mining Group over the Beaulieu River belt. These surveys were followed by staking, ground geophysics and geological mapping. Of particular interest to these companies were belts of acid volcanics of the Duck and Banting Formations of the Yellowknife Supergroup (Henderson,1970). To the end of 1970 none of the anomalies staked had been tested by the drill but it is expected that several thousand feet of drilling will be completed within the next two years.

In the Keewatin several companies including Penarroya Canada Ltée.and a syndicate made up of Fort Reliance Minerals, Redstone Mines Ltd., Ensign Oils Ltd. and More Mines Ltd. are examining the copper and base metal potential of the Ennadai-Rankin Inlet greenstone

belt, the geology and mineralization of which has been discussed earlier at this meeting by Dr. Ridler of the Geological Survey.

A new copper discovery has been announced south of this belt in the vicinity of Poorfish Lake (60°15'N, 100°45 W) by a consortium of companies including Yellowknife Bear Mines Ltd., Chieftain Development Co. Ltd., Imperial Oil Enterprises Ltd. and Blue Crown Petroleum.

Aquitaine of Canada Ltd. conducted an extensive aerial geophysical survey over portions of twenty-three permits covering the metasediments of the Penrhyn Group northeast of Repulse Bay at the southern end of the Melville Peninsula. Numerous gossans were mapped within these metasediments by the Geological Survey of Canada during the course of their regional mapping operations in 1964 but little prospecting work had been carried out in this district before Aquitaine's permits were issued in 1970.

Lead and Zinc

The dollar value of the Yukon and Northwest Territories mineral production is dominated by the contribution of two mines, Anvil and Pine Point, both producers of lead and zinc. It is possible that this situation will continue for some time to come as the lead-zinc potential of the two territories is significant.

The zinc-silver-lead-copper prospect of Bathurst Norsemines Ltd., situated 300 miles northeast of Yellowknife and 50 miles southwest of the southern tip of Bathurst Inlet (65°55'N, 108°20'W), contains significant tonnages of ore grade material (see Table 2). The deposit lies in an arcuate zone in quatz-mica schists, quartzites and garnet amphibolites. On the basis of present mapping this belt is shown as folded and metamorphosed sediments equivalent to the sediments of the Yellowknife Supergroup. However, the presence of several altered limestone horizons on the property may mean that the belt is analogous to the Proterozoic Snare Group rather than the Archean Yellowknife Supergroup. The belt is wrapped around a later

granitic intrusion. This prospect bears some resemblance to the zinc-silver-lead property of Indian Mountain Metal Mines located 120 miles east of Yellowknife. Here the deposit is in a generally conformable sequence of quartzite and garnetiferous quartz-biotite gneiss. Metamorphism of this belt is related to a late granitic intrusion lying just east of the property. It may be that there are other significant base metal deposits in hitherto undifferentiated Aphebian/Archean metasedimentary belts within the Slave geological Province.

Hudson Bay Exploration and Development Co. conducted an advanced exploration program on the Tom property in MacMillan Pass between the Yukon and the Mackenzie District (63°10'N, 130°09'W). The underground program started in May from the portal prepared in 1969 and continued through to early December. In all, 6,000 feet of underground workings explored an east and a west ore zone. From stations in the drifts, a total of 20,000 feet of diamond drilling was done. The deposit is a bedded, stratiform body containing lead, zinc and barite within a thick series of argillites, siltstones, conglomerates and minor limestone. Results to date indicate 5 million tons of ore which has a combined grade of 16% lead and zinc with slightly less than 3 ounces of silver per ton.

Lead-zinc-silver vein type deposits are presently being mined at Keno Hill and are known on the Matt Berry property in the Yukon (61°28'N, 129°25'W) now under option to the International Nickel Company of Canada and Metallgesellschaft A G and on Cadillac Exploration's Prairie Creek property in the Northwest Territories (61°33'N, 124°47'W) now under option to Penarroya Canada Ltée. Underground development work and drilling in 1970 by Penarroya at Prairie Creek have indicated a section, their No. 3 showing, which contains two million tons of ore grading 11% Pb, 13% Zn and 5 oz. Ag/ton. The Prairie Creek deposit is apparently controlled by faulting.

Mississippi Valley type deposits are now being mined at Pine Point Mines in the Northwest Territories from a Devonian carbonate (dolomite) sequence.

The lead-zinc deposits of Bankeno Mines on Little Cornwallis Island and the deposit of Texas Gulf Sulphur on northern Baffin Island also occur in dolomite. The Bankeno occurrences consist of sphalerite and galena in vuggy, brecciated dolomites of Ordovician age. The Texas Gulf Sulphur deposit occurs as a narrow, nearly horizontal, sinuous deposit containing pyrite, sphalerite and minor galena which lies within the Society Cliffs Formation near Strathcona Sound. The age of the Society Cliffs Formation is presently thought to be late Proterozoic but may in fact be lower Paleozoic.

King Resources Ltd. for the past two years have been examining the Society Cliffs Formation from Strathcona Sound to Milne Inlet.

Sangster (1970) has suggested that large carbonate sequences of lower Paleozoic age are prime geological targets for lead-zinc exploration. Such sequences exist in the eastern Cordillera, on northern Cornwallis Island and southwestern Devon Island, on north-eastern Ellesmere Island and on Southampton Island. Many of these areas have yet to be investigated in detail.

Uranium

The announcement of the discovery of uranium by Gulf Minerals in northeastern Saskatchewan in December,1968 brought many companies into the Territories to examine the uranium potential of the Aphebian conglomerates and sandstones in the Baker Lake-Dubawnt Lake area and farther south in the Padlei-Henik Lakes region. In 1969, 87 permit areas were granted. By 1970 no less than eight drills were busy examining the potential of the Hurwitz Group at Amer Lake ($65^{o}32'N$, $96^{o}45'W$), the Hurwitz Group and the Montgomery Lake sediments in the Padlei region ($61^{o}53'N$, $96^{o}40'W$) and the contact between the Kazan sandstones and Christopher Island volcanics near Baker Lake. Several new discoveries were made including two interesting discoveries by the Dynamic Group of Companies in the basement rocks

underlying the Dubawnt Group in the vicinity of Baker Lake. Additional work will be required to evaluate these finds.

The Gulf discovery is apparently associated with a mylonite zone in the gneissic rocks of the Wollaston Trend (Cawley, 1970). Similar gneissic and schistose rocks with uranium mineralization are known in the Rocher River-Fort Smith belt south of the East Arm of Great Slave Lake, an area covered in 1969 and 1970 by the Geological Survey's airborne gamma spectrometry surveys (Darnley et al, 1970; Darnley, 1971; Charbonneau, 1971). A radiometric high north of Tsu Lake (61°N, 111°55'W), discovered by the GSC in 1969, was staked and prospected by Cominco Ltd. during 1970. The anomaly occurs over a radioactive granite porphyry located between north-striking fault zones (Charbonneau, 1971). Shear zones 2 to 3 feet wide and a few hundred feet long located within the porphyry are further enriched with uranium and thorium.

During the fall of 1969 Vestor Explorations Ltd. staked a uranium showing on North Simpson Island (61°45'N, 112°28'W). The radioactive zone was related to coarse clastics near the base of the Sosan Formation of Aphebian age. During the winter and the summer of 1970 nearly all the outcrops of Sosan Formation within the East Arm of Great Slave Lake were staked by Vestor and by Great Plains Development Co. Ltd. The number of known, possibly significant, uranium zones within the Sosan has grown to twelve within the past year. The radiometric clastic strata occur in association with minor volcanics including pyroclastics, mudstones, dolomite sands and polymictic conglomerates and are moderately to steeply dipping. Several of the uranium showings are bounded by high angle faults. The Sosan Formation rests on granites with a possible paleosol at the unconformity (Bottrill, 1971). The presence of the coarse clastic strata, the preserved paleosol and the associated volcanics may indicate a similar environment for ore formation to that responsible for the uraniferous conglomerates at Elliot Lake. Drilling is now underway

on Vestor's No. 5 showing, a zone 1,000 feet long and 400 feet wide from which assays of greater than 1.0% U_3O_8 have been obtained.

Nickel

Nickel was first produced in the North at Rankin Inlet by North Rankin Nickel Mines Ltd. from 1957 to 1962 from a series of deposits near the footwall of a serpentinite sill 200 to 300 feet thick which intrudes a series of intermediate to basic volcanics of Archean or of Aphebian age (Wright, 1967).

A second nickel mine, this time in the Yukon, is now being readied for production. Milling is scheduled to begin early in 1972, at 600 tons per day, at the deposit of Hudson-Yukon Mines Ltd. situated on Quill Creek in the southwest Yukon, eight miles west of the Alaska Highway (61°28'N, 135°29'W). Discovered in 1952, the property was carefully examined during the following four years during which time some 14,000 feet of underground workings and 65,000 feet of diamond drilling were completed. Reserves of 738,000 tons containing 2.04% nickel, 1.42% copper with minor cobalt, platinum and palladium were established. The sulphide ores, pyrrhotite, chalcopyrite and pentlandite occur as massive to heavily disseminated lenses within and adjacent to a gabbroic footwall zone of an ultramafic sill (Findlay, 1969).

In 1968 the company began a reinvestigation of the property with a brief geophysical program followed by more diamond drilling in 1969. Cleaning out and slashing the old workings has been in progress since mid 1970. Mill construction and townsite preparation are in progress.

Considerable interest has been exhibited in recent years in small high grade deposits of nickel and cobalt arsenides which occur along the north shore of the East Arm of Great Slave Lake from the mouth of the Francois River to Sachowia Point and on adjacent islands. Two of these deposits, one owned by Jason Explorers Ltd. on Blanchet Island (61°58'N, 112°26'W) and a second owned by Copper Pass Mines Ltd. on Sachowia Lake (62°24'N, 111°52'W), have shipped

700 tons of high grade nickel-cobalt ore to smelters in Europe during the past year. The arsenides are associated with veins and sills of granitic composition which in turn may be related to the intrusion of granodiorites and quartz diorites along the southeast shore of the East Arm. Although the deposits are discontinuous their grade, often averaging better than 30% nickel over 4 feet, makes them attractive prospects for small mining operators.

In the northern Keewatin District, several companies including King Resources Ltd., Falconbridge Nickel Mines Ltd., Aquitaine of Canada and Cominco Ltd. are examining a series of small basic intrusions and ultrabasic sills and dykes which strike southwestward from Committee Bay to the Hayes River and beyond. The sills consist of thin, alternate layers of brown-weathering, serpentine-actinolite bands and grey-weathering, green-black amphibolite bands (Heywood, 1967). The origin and mineral potential of these intrusions are as yet unknown.

Silver

Interest is continuing in the Camsell River - Great Bear Lake area and with considerable justification. Echo Bay Mines Ltd. at Port Radium is now one of the largest silver producers in Canada. The silver is contained in quartz carbonate veins rich in native silver, argentite, chalcopyrite, nickel-cobalt arsenides, bismuth and minor uraninite. The veins cut the Proterozoic Echo Bay Group of acidic tuffs, breccias and associated volcanics and sediments. Thirty-five miles south of Echo Bay Mines, Terra Mining and Exploration Co. Ltd. are now mining narrow silver and silver-bismuth veins in a similar geological setting (Thorpe,1971).

Norex Resources Ltd., two miles southwest of Terra, are now drilling in an attempt to establish continuity with depth of a high-grade, silver-bismuth zone ten feet wide on the surface from which they removed over 90,000 oz. of silver in 1970.

Many other silver-copper-bismuth-cobalt showings are known in the district including the old properties of the Acadia Mine on Contact Lake, the El Bonanza Mine, six miles southwest of Port Radium and the Silver Bay property across the Camsell River from Norex Resources.

Other Minerals

Tungsten occurrences are receiving close attention both in the region northeast of Yellowknife and in the Selwyn Mountains.

In 1970, the Hudson Bay Exploration and Development Co. completed 1,000feet of diamond drilling on their OMO claims (62°45'N, 130°W) and intend further drilling in 1971.

Amax Exploration Inc. drilled their Mactung property (63°17'N, 130°09'W) in 1968. In 1970, a 9-mile road was built from the Canol Road to the property in preparation for further exploration in 1971.

Canada Tungsten Mining Corp. Ltd. (61°57'N, 128°15'W) drilled their present pit area, below and beyond the skarn zone presently regarded as ore reserves. Below the skarn is mineralized chert. The mining of this chert could extend the mine life several years.

Coal exploration is attracting interest and during the past year at least two firms were active in the Carmacks area, where the Tantalus Butte Mine is a producer of coal for Anvil. N.H.Ursel and Associates took out permits covering coal exploration around Braeburn Lakes, south of Carmacks. Teslin Explorations Ltd. of Calgary, constructed a 4 mile access road from the Dawson Trail and did some1,000 feet of trenching for sampling in a coal deposit 12 miles southwest of Braeburn (61°20'N, 136°W).

FUTURE DEVELOPMENTS

It is anticipated that the following areas will attract considerable attention in the next few years:

(1) the greenstone belts of the Slave Province,
(2) the Ennadai-Rankin Inlet greenstone belt,
(3) the Mackenzie and the Selwyn Mountain belts,
(4) the Canadian Arctic islands,
(5) the basic and ultrabasic rocks in the northern Keewatin and northeastern Mackenzie districts,
(6) the East Arm of Great Slave Lake,
(7) the Dawson and Nisling ranges,
(8) the Camsell River-Great Bear Lake area.

Other regions than these listed above have favourable geology but in the north it is not always enough to prospect in an area with favourable geology. The transportation and labour costs involved in bringing a mine into production in the Yukon and Northwest Territories require that this mine (a) have an excellent grade of ore or (b) have very large reserves or (c) be situated close to predicted transportation routes. It is the possibility of finding a deposit that will fit the above conditions that will attract exploration dollars to these regions in the immediate future.

The greenstone belts in southern Canada contain many large mines and significant discoveries are continuing to be made in belts that have been examined many more times than the greenstones of the Northwest Territories.

The deposit of Casino Silver Mines Ltd. is a known example of a large-tonnage, low-grade occurrence within the northern Canadian Cordillera. The possibility of finding several more such deposits will continue to attract exploration crews to examine known showings in the Dawson and Nisling ranges and to examine the potential of the Selwyn and Mackenzie Mountains which have just recently been mapped by the Geological Survey.

The present boom in oil and gas exploration in the northern Yukon, the Mackenzie Valley and the Arctic Islands will spur the construction of new transportation facilities in the North and thus make many areas more attractive for mineral exploration. The proposed pipelines through the Mackenzie Valley will require the construction of a service road which will bring easy access to many areas of the Mackenzie Mountains. The small airstrips built by oil companies in the western Arctic Islands will enable prospecting crews to move through this area at greatly reduced costs. The voyages of the Manhattan have suggested that properly designed ore carriers could travel into Lancaster Sound for as many as ten months of the year.

If individual deposits of minerals with significant tonnages and grades can be located throughout northern Canada, transportation will follow and with the advent of good transportation facilities, be they roads, railways, giant ore carriers, hovercraft or Boeing 747's, smaller properties will become economic. One has only to look at the clusters of mines in the greenstones of northern Ontario or in the Highland Valley area of British Columbia to be convinced that mineral deposits often occur in close proximity to each other.

GOVERNMENT INVOLVEMENT IN NORTHERN DEVELOPMENT

The Government of Canada has actively involved itself in the development of the mineral resources of the north. From 1967 to the end of 1970 over $3.6 million dollars has been paid out to mining and exploration companies under the Northern Mineral Exploration Assistance Program. Smaller but significant amounts have been paid out under the Prospectors Assistance Program (up to $60,000/year), the Tote Trail Assistance Program (up to $200,000/year) and the Resource Airstrip Assistance Program (over $100,000/year). The Geological Survey of Canada has been active in the north since 1887 and has greatly accelerated its programs in recent years. Road construction has been stepped up to the rate of $10 million dollars

year. The government is aware of the high cost of mine development orth of 60 and has exhibited a willingness to co-operate with ining companies in the establishment of the infrastructure required o bring a mineral prospect into production.

The government is also aware of its responsibilities to orthern people and to all Canadians to provide useful and continuing obs for northerners and to protect the environment. To serve these ids it has recently appointed employment liason officers to work .th companies exploring and developing the north, It also has enacted egislation controlling the pollution of Arctic waters (the Arctic ters Pollution Act) and the use of Northern inland water systems he Inland Waters Ltd). As the honourable Jean Chretien stated in e House of Commons on March 3, 1970, "By acting with determination and cisiveness today we may ensure that 20 or 30 years from now we will t be faced with settling another tremendous debt as the price of difference and mismanagement of the water of the North."

Regulations are also being formulated to control the use land north of 60^{0}. This legislation is not intended to hamper rthern development but is meant to ensure that this development oceeds in such a fashion that the north will be spared the disasters environmental mismanagement that now plague other parts of Canada.

SUMMARY

In the past 100 years mines in the north have produced erals valued at 1.7 billion dollars. Of this total 12% or million dollars was produced in 1970. This production figure 1970 represents less than 10% of the total value of minerals duced in Canada last year.

However, reserves of producing mines total 3.7 billion lars at today's prices and mineral deposits containing metals th more than 25 billion dollars have been delineated, but have yet been developed.

It is a certainty that, with the extension of the present transportation network and the introduction of new transportation concepts, many of these deposits will be mined. The improved transportation will in turn accelerate the discovery of new prospects. Thus in the 70's it is not unreasonable to anticipate a substantial increase in the value of minerals mined north of 60° and to suggest that the north will become a more significant factor on the Canadian Mining scene.

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TABLE 1

1970 Production and Reserves of Operating Mines North of 60°

Mine	Tons Milled	Tons/Day	Production	Mill Head Grade	Reserves in tons(a)	Value of Reserves(b)
United Keno Hill Mines	82,215	225	6,946,332 lb. Pb 8,183,673 lb. Zn 2,663 584 oz. Ag 104,876 lb. Cd	4.23% Pb 4.98% Zn 32.4oz Ag/ton .06% Cd	100,000	$ 8,400,000
Anvil Mine	1,955,866	5,358	120,355,000 lb. Pb 138,779,000 lb. Zn 1,895,843 oz. Ag 2,730 oz. Au	3.08% Pb 3.55% Zn .96oz Ag/ton .tr Au	63,~~000,000~~	$1,827.000,000
New Imperial Mine	852,693	2,336	16,084,731 lb. Cu 211,614 oz. Ag 5,856 oz. Au	.94% Cu .25 oz. Ag/ton .tr Au	9,000,000	$ 148,500,000
Cassier Asbestos	1,245,087	3.411	104,386 tons As	8.4%	23,000,000	$ 386,000,000
Venus Mine (commenced operations Sept.1970)	23,491	193	345,860 lb. Pb 236,905 lb. Zn 76,970 oz. Ag 1,791 oz. Au 2,908 lb. Cd	7.36% Pb 5.04% Zn 3.29 oz. Ag/ton .08 oz. Au/ton .006% Cd	110,000	$ 4,800,000
Tantalus Butte	16,790	46	16,790 tons coal	-	?	$ 1,200,000 (c)
Con Mine	147,285	405	88,673 oz. Au	.60 oz. Au/ton	?	$ 9,300,000 (c)
Giant Yellowknife Mine (includes production from Supercrest & Lolor	424,774	1,167	228,731 oz. Au	.54 oz. Au/ton	1,613,500	$ 39,000,000
Echo Bay Mines	36,925	101	2,511,267 oz. Ag 782,488 lb. Cu	68 oz. Ag/ton 1,06% Cu	?	$ 14,300,000 (c)
Pine Point Mines	3,859,838	10,604	216,777,060 lb. Pb 512,071,460 lb. Zn	2.81% Pb 6.63% Zn	40,000,000	$1,140,000,000
Terra Mining & Exploration	29,266	96	339,012 oz. Ag 505,372 lb. Cu	11.5 oz. Ag/ton .86% Cu	?	$ 2,500,000 (c)
Canada Tungsten Mine (1969 Production)	167,389	482	4,063,488 lb. WO_3 466,113 lb. Cu	1.54% WO_3 .21% Cu	818,000	$ 75,000,000

(a) Reserve figures are the last available. Grade of reserves often slightly different from mill head grade.

(b) Prices used to calculate reserves Ag $1.75/oz. Pb & Zn $ .15/lb. Iron $ 11.00/ton (68% Fe) Cd $3.80/lb.
Cu $ .50/lb. Gold $35.00/oz. Asbestos $200/ton W $2.75/lb.

(c) For companies with unstated reserves value figure has been calculated as 3 times value of present years production.

Gross Value of Some of the Undeveloped Mineral Deposits North of 60°

Developer	Location	Product	Grade	Estimated Tonnage	Gross Value in $ (a)	References
Coppermine River Ltd.	Coppermine Area NWT	Cu	2.96%	4,162,433	123,000,000	Canada Mines Handbook (1970)
Kennarctic Explorations Ltd.	High Lake, NWT	Cu Zn	3.53% 2.46%	5,206,856	222,000,000	N. Miner 30/3/67
Bathurst Norsemines Ltd. (Cominco Option)	Hackett River Area NWT	Pb-Zn Ag	8 % 9 oz/ton	>10,000,000	> 400,000,000	N. Miner 28/1/71
Borealis Exploration Ltd.	West Melville Pen. East Melville Pen.	Fe Fe	40 % 30 %	2,600,000,000 1,100,000,000	16,300,000,000 5,200,000,000	N. Miner 17/9/70
Baffinland Iron Mines	Mary River Area Northern Baffin Island, NWT	Fe	68 %	127,700,000	1,405,000,000	N. Miner 8/9/66
Cadillac Explorations Ltd. (Penarroya Can.Ltd. Option)	Prairie Creek Mackenzie Mts. NWT	Pb Zn Ag	11 % 13 % 5 oz/ton	2,000,000	173,000,000	N. Miner 3/12/70
Bankeno Mines Ltd. (Cominco Option)	Little Cornwallis Island, NWT	Pb Zn	2 % 13 %	900,000	40,000,000	Financial Post, Survey of Mines, 1970
Conwest Exploration Ltd.	Pine Point Area NWT	Pb-Zn	13 %	1,350,000	53,000,000	N. Miner 6/8/70
Coronet Mines Ltd.	Pine Point Area	Pb-Zn	10.2%	1,372,735	42,000,000	Financial Post, Survey of Mines, 1970
Indian Mountain Metal Mines Ltd.	Indian Mtn. Lake Area, BB Zone, NWT	Zn Pb Ag	10.3% 0.9% 3.45 oz/ton	1,300,000	51,000,000	Financial Post, Survey of Mines, 1970
Hart River Mines Ltd.	Hart River, Yukon	Ag Au Cu Pb. Zn	1.45 oz/ton 0.41 oz/ton 1.45% .87% 3.65%	1,177,445	53,000,000	N. Miner 2/10/69
Casino Silver Mines Ltd.	Casino Creek Yukon	Cu Mo	0.37% 0.023%	179,000,000	805,500,000	Phillips and Godwin, 1970
Hudson Bay Exploration & Development Ltd.	MacMillan Pass Yukon	Pb Zn Ag	8 % 8 % 2.7 oz/ton	5,000,000	263,500,000	Personal Communication to D. B. Craig

(a) Gross value calculated using following prices: Pb-Zn $ .15/lb. Ag $ 1.75/oz. Cu $.50/lb. Fe $11.00/ton at 68% Fe
Mo $1.70/lb. Au $35.00/oz.

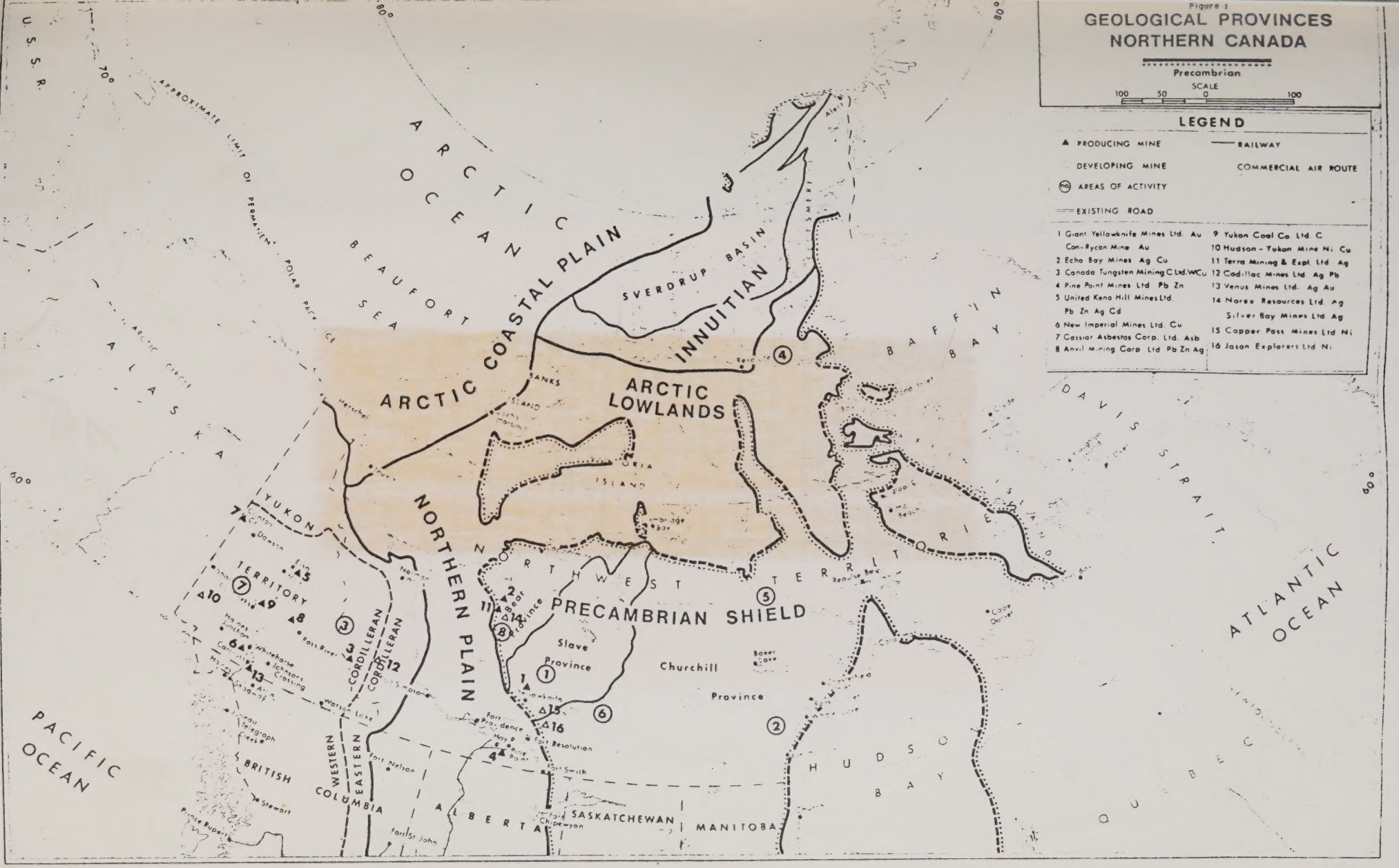
Figure 1
GEOLOGICAL PROVINCES
NORTHERN CANADA
Precambrian
SCALE
100 50 0 100
LEGEND
PRODUCING MINE
DEVELOPING MINE
AREAS OF ACTIVITY
EXISTING ROAD
RAILWAY
COMMERCIAL AIR ROUTE
1 Giant Yellowknife Mines Ltd. Au
Con-Rycon Mine Au
2 Echo Bay Mines Ag Cu
3 Canada Tungsten Mining C Ltd. W Cu
4 Pine Point Mines Ltd Pb Zn
5 United Keno Hill Mines Ltd.
Pb Zn Ag Cd
6 New Imperial Mines Ltd. Cu
7 Cassiar Asbestos Corp. Ltd. Asb
8 Anvil Mining Corp Ltd Pb Zn Ag
9 Yukon Coal Co Ltd. C
10 Hudson - Yukon Mine Ni Cu
11 Terra Mining & Expl. Ltd Ag
12 Cadillac Mines Ltd. Ag Pb
13 Venus Mines Ltd. Ag Au
14 Norex Resources Ltd. Ag
Silver Bay Mines Ltd. Ag
15 Copper Pass Mines Ltd Ni
16 Jason Explorers Ltd Ni
ARCTIC OCEAN
BEAUFORT SEA
APPROXIMATE LIMIT OF PERMANENT POLAR PACK ICE
ARCTIC COASTAL PLAIN
SVERDRUP BASIN
INNUITIAN
ARCTIC LOWLANDS
NORTHERN PLAIN
PRECAMBRIAN SHIELD
CORDILLERAN
WESTERN CORDILLERAN
EASTERN CORDILLERAN
BAFFIN BAY
DAVIS STRAIT
ATLANTIC OCEAN
HUDSON BAY
PACIFIC OCEAN
U.S.S.R.
ALASKA
YUKON TERRITORY
NORTHWEST TERRITORIES
BRITISH COLUMBIA
ALBERTA
SASKATCHEWAN
MANITOBA
ONTARIO
QUEBEC
Slave Province
Churchill Province
Banks Island
Victoria Island
Somerset Island
Prince of Wales Island
Melville Island
Ellesmere Island
Devon Island
Baffin Island
Hudson Bay
Great Bear Lake
Great Slave Lake
Baker Lake
Whitehorse
Johnson's Crossing
Watson Lake
Dawson
Mayo
Stewart
Prince Rupert
Fort Nelson
Fort Liard
Fort Simpson
Fort Providence
Fort Resolution
Fort Smith
Fort Chipewyan
Fort St. John
Hay River
Pine Point
Yellowknife
Coppermine
Cambridge Bay
Resolute Bay
Cape Dorset
Frobisher Bay
Pond Inlet
Alert
Eureka
Hershel
Norman Wells
Inuvik
Aklavik
Tuktoyaktuk
Old Crow
Carcross
Faro
Ross River
Carmacks
Haines Junction
Teslin
Atlin
Telegraph Creek
Jasper
Grande Prairie
Peace River
Edmonton
Calgary
Lethbridge
Medicine Hat
Regina
Swift Current
Moose Jaw
Prince Albert
Saskatoon
Yorkton
Brandon
Portage la Prairie
Winnipeg
Thompson
Flin Flon
The Pas
Churchill
Sioux Lookout
Kenora
Fort Frances
Thunder Bay
Sault Ste. Marie
Sudbury
North Bay
Timmins
Kapuskasing
Cochrane
Moosonee
Kirkland Lake
Rouyn
Noranda
Val d'Or
Chibougamau
Chapais
Matagami
Schefferville
Wabush
Labrador City
Goose Bay
Happy Valley
Hopedale
Nain
Cape Dorset
Frobisher Bay
Pond Inlet
Resolute Bay
Cambridge Bay
Coppermine
Yellowknife
Hay River
Fort Smith
Fort Resolution
Fort Providence
Fort Simpson
Fort Liard
Fort Nelson
Fort St. John
Dawson Creek
Prince George
Kamloops
Vernon
Kelowna
Penticton
Nelson
Trail
Castlegar
Cranbrook
Kimberley
Revelstoke
Golden
Prince Rupert
Stewart
Terrace
Kitimat
Queen Charlotte Islands
Vancouver Island
Victoria
Nanaimo
Courtenay
Port Alberni
Campbell River
Port Hardy
Tofino
Ucluelet
Bella Coola
Williams Lake
Quesnel
Prince George
Dawson Creek
Fort St. John
Fort Nelson
Fort Liard
Fort Simpson
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Jasper
Atlin
Telegraph Creek
Haines Junction
Carmacks
Ross River
Faro
Carcross
Old Crow
Tuktoyaktuk
Aklavik
Inuvik
Norman Wells
Hershel
Eureka
Alert
Pond Inlet
Baffin Island
Devon Island
Ellesmere Island
Prince of Wales Island
Somerset Island
Victoria Island
Banks Island
Melville

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